AN3970
Application note

PLM smartplug V2 getting started

Introduction

The purpose of this guide is to help the user fully use the PLM smartplug demonstration board in a network with other smartplug boards and a data concentrator.

The document describes how to configure the board and how to interact with it; buttons, LEDs, configuration jumpers, and all hardware components used, are described in detail. A full description of the power line communication and its configuration and commands is also provided.

The PLM smartplug demonstration board is based on the STM32F103CB microcontroller, the ST7540 PLM module, and the STPM01 mono-phase energy metering IC. It implements a PLM smartplug node which allows to monitor the energy consumption of a mains plug and to control any kind of load in on/off mode by a relay. If the user wants to control a load supplied by the monitored mains plug, it is necessary to respect a specific cabling scheme described in *Section 2*. Moreover it is designed to fit a standard “503” wall box.

The voltage, current, power, active energy and the output status can be sent to a PLM data concentrator through a power line communication network on request. Moreover, if the power consumption changes, it is sent asynchronously to the data concentrator.

- *Section 1* describes document and library rules
- *Section 2* describes the smartplug hardware demonstration board, its modes, uses and limitations
- *Section 3* highlights how to use the smartplug board in a PLC network. Refer to the PLM smartplug FW UM1459 user manual for more firmware and communication protocol details
- *Section 4* shows the board schematics and bill of material. Refer to the PLM smartplug HW UM1458 user manual for more hardware details.

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1 Document and library rules

This document uses the conventions described in the sections below.

1.1 Acronyms

Table 1 lists the acronyms used in this document.

Table 1. List of acronyms

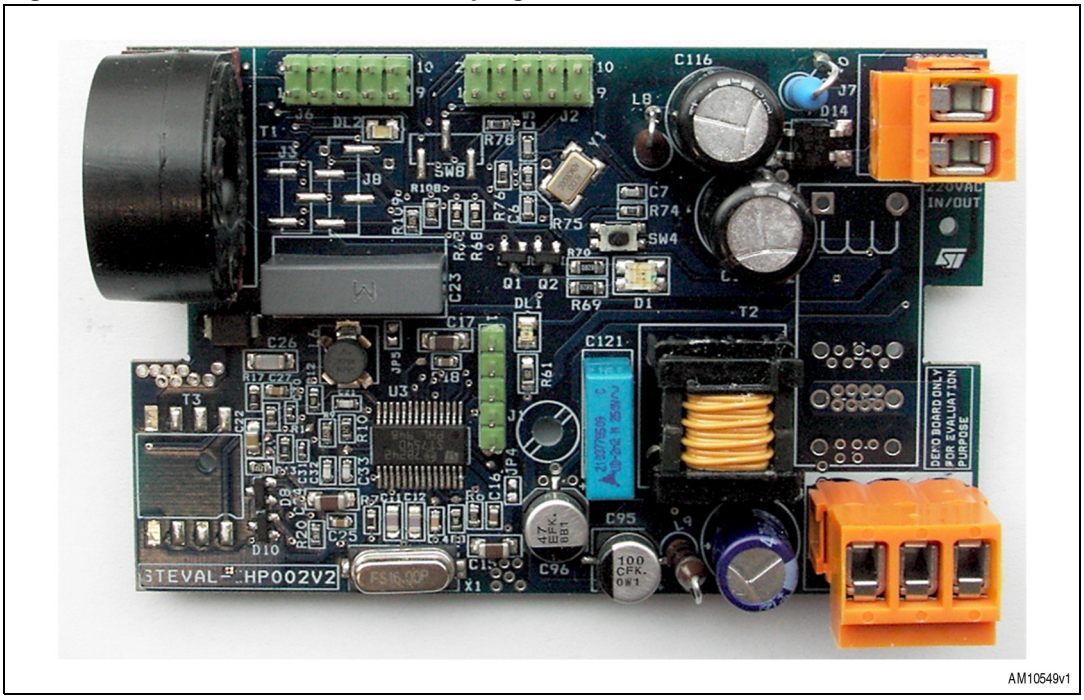
Acronym	Meaning
APP	Application
API	Application programming interface
HAL	Hardware abstraction layer
RTOS	Real time operating system
PLM	Power line modem
PLC	Power line communication
MCU	Microcontroller unit
SPI	Serial peripheral interface
OOP	Object oriented programming

2 PLM smartplug demonstration board

2.1 Board introduction

The application described in this document refers to the STEVAL-IHP002V2 demonstration board (see UM1458).

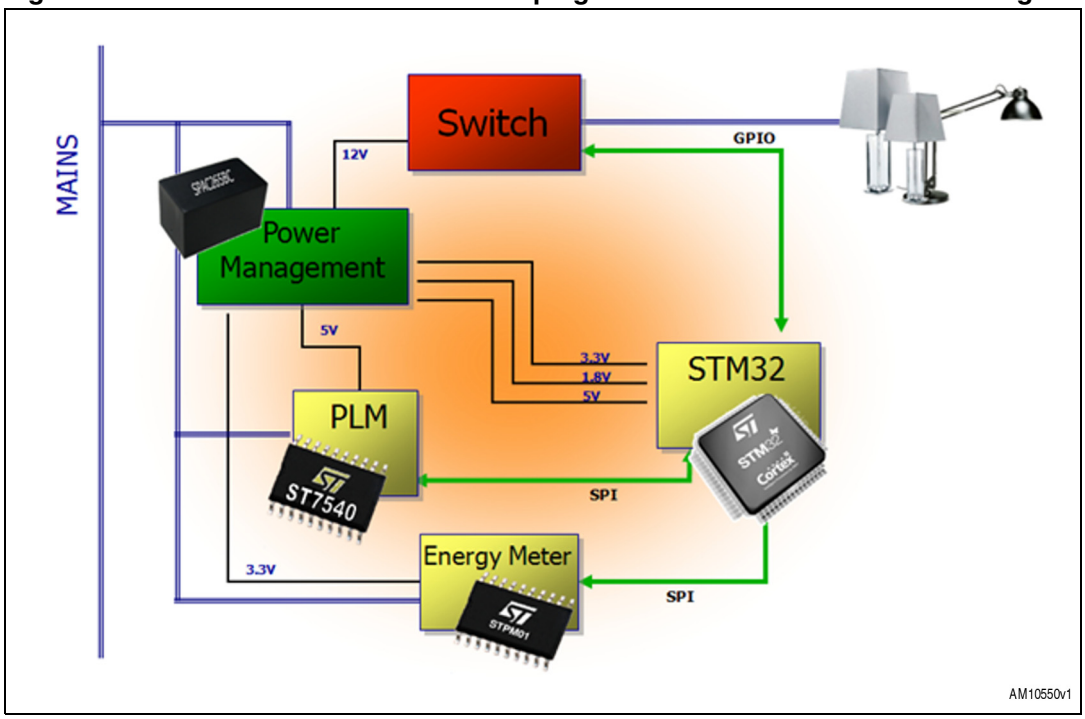
Figure 1. STEVAL-IHP002V2 smartplugV2 demonstration board



The board includes the following functions shown in the block diagram of *Figure 2*:

- Energy measurement by STPM01 IC
- Power line communication by ST7540 up to 4.8 kbps
- UART connectivity or expansion connector
- Output with two contacts (NO/NC) and common contact for generic load.

Figure 2. STEVAL-IHP002V2 PLM smartplugV2 demonstration board block diagram



Warning: **The board must be used only by expert technicians. Due to the high voltage (220 Vac) special care should be taken with regard to human safety. There is no protection against accidental human contact with high voltages. After disconnection of the board from the mains, none of the live parts should be touched immediately because of the energized capacitors. It is mandatory to use a mains insulation transformer to perform any debugging/tests on the board in which debugging and test instruments like USB-JTAG dongles, spectrum analyzers, or oscilloscopes are used. Do not connect any oscilloscope probes to high voltage sections in order to avoid damaging instruments and demonstration tools. STMicroelectronics assumes no responsibility for any consequences which may result from the improper use of this tool.**

2.2 Main hardware components

The following is a list of the PLM smartplug demonstration board main hardware components:

- An STM32F103CB microcontroller running the application firmware
- An STPM01 mono-phase energy metering IC
- An ST7540 power line modem: used to provide PLC connectivity to the system
- 1 bi-color status LED: green/red LED for application status scope
- 1 configuration jumper (SW8): used to inform the MCU that the STPM01 calibration tool is connected
- 1 microcontroller reset button (SW4): used to force an MCU reset
- 1 USART expansion connector for configuration (J3)
- 1 I^2C expansion connector for dual-interface EEPROM connection (J8).

Detailed information about the PLM smartplug demonstration board hardware can be found in the UM1458 user manual.

2.3 Power-on and board usage

Before turning on the board for the first time, make sure that the following configuration jumpers are fitted or unfitted according to the following default table:

Table 2. Jumper default position

Jumper	Description	Default
SW8	– Fitted (1-2): calibration mode – Fitted (2-3): normal mode	Fitted (2-3)

2.3.1 PLM smartplug application configuration

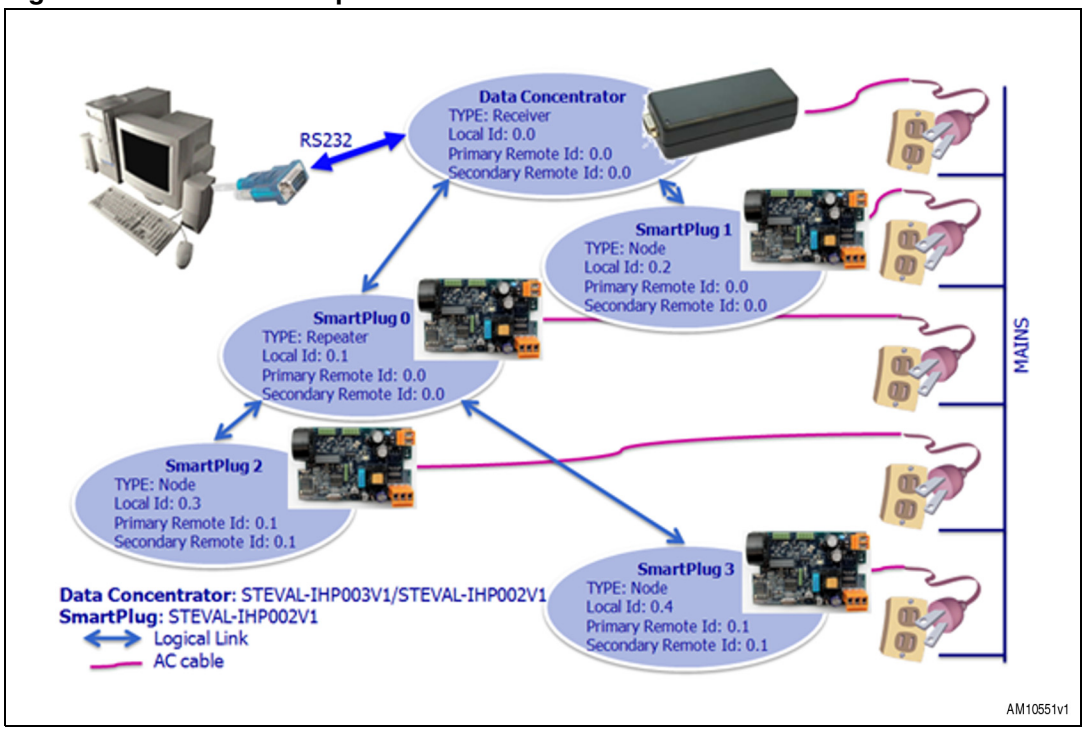
The STPM01 is configured to work using the internal shadow latch which is loaded with parameters stored in the internal flash of the MCU; however the STPM01 can be calibrated by putting jumper SW8 in calibration mode and using the on-board calibration connector before powering up the board. For details please refer to the UM1458 user manual.

The first time the board is powered up, information regarding the addresses used for the communication protocol and the network functions, which are stored in the MCU embedded Flash, are blank; therefore, after the first boot this information must be initialized using a PC software application running on a PC connected to the board by the RS232 port adaptor connected to the expansion connectors J3 and J1; for details about this configuration procedure please refer to the AN3046 application note. For the PLM smartplug board the procedure described in AN3046 must be used only for configuration purposes.

2.3.2 PLM smartplug application running

After configuration, the board can be used in a network; the address configuration of each board must be consistent with the chosen network topology: *Figure 3* shows an example of a network and the related network addresses and node function configuration.

Figure 3. Network example



The data concentrator firmware is also provided in order to build a complete network solution; it can be loaded into one of the available smartplug boards (STEVAL-IHP002V2) or it is possible to order STEVAL-IHP003V1 separately, which has a better form factor for PC connection, and program it with the data concentrator firmware.

The data concentrator accepts commands, provides the command responses, and also the asynchronous messages from smartplugs and some debug information through the RS232 connection; a basic I/O text terminal has been implemented through this connection in order to provide the commands and print responses by text using a terminal PC software such as “HyperTerminal”; the local echo of the terminal software must be enabled in order to have a visual text feedback. Each text command must be completed by the <enter> key and is “case” sensitive. The following commands are implemented:

Table 3. Terminal commands

Commands	Description
“get”	Used to request information to a remote smartplug. After the command the modem answers with the string “COMMAND->GET” to confirm the command acquisition and waits for one of the command classes which identify the data to request. The command classes are described in *Table 4*.
“set”	Used to write information to a remote smartplug. After the command the modem answers with the string “COMMAND->SET” to confirm the command acquisition and waits for one of the command classes which identify the data to write. The command classes are described in *Table 4*.
“identify”	Used to identify a specific smartplug inside the network. After the command the modem answers with the string “COMMAND->IDENTIFY” to confirm the command acquisition and wait for the string “single” followed by the <enter> key to complete the command. The command completion is confirmed by the string “CLS-> single”; after the command the modem waits for the node ID to identify printing the string “<NODE_ID>”. The smartplug identified by the inserted node ID flashes its LEDs.
“list”	Used to list the smartplug in the network already connected to the data concentrator. After the command the modem answers with the string “COMMAND->LIST NODES” and with the list of the smartplug ID and address
“route”	Used to print the routing table. After the command the modem answers with the string “COMMAND->ROUTE” and with the routing table

For the commands “get” and “set” it is possible to specify the class variable to write/read; *Table 4* describes these variables. The text terminal interface is also used to show debug information: each received frame is printed in hexadecimal format and the payload information is printed too, as shown in the following examples for the frame transferring all measurement information and for the one transferring the status information:

```
Frame Rx ->
00 00 03 00 00 02 01 BC 82 03 00 00 00 00 00 00 00 00 00 00 00 00
01 BC 82 03 00 00 00 00 00 00 00 00 00 00 00 00
RSP Voltage -> 230076   Current -> 0    Power -> 0      Energy -> 0


Frame Rx ->
00 00 03 00 01 02 02 01 FF FF
02 01 FF FF
RSP Type -> 1   Main Val -> 255 Aux Val -> 255
```

In addition to the debug information, the information extracted by the application layer is printed, as shown in the following example:

Smartplug-id:voltage;current;power;

Where

- id: smartplug ID (0..255)
- voltage: mains voltage in mVolt
- current: load current in mAmpere
- power: load power consumption in Watt.

After setting a new status of the mains output the smartplug sends back a frame with the new status and the data concentrator prints out the following text message:

Status-id:status;

Where

- id: smartplug ID (0..255)
- status: smartplug output status (0..255).

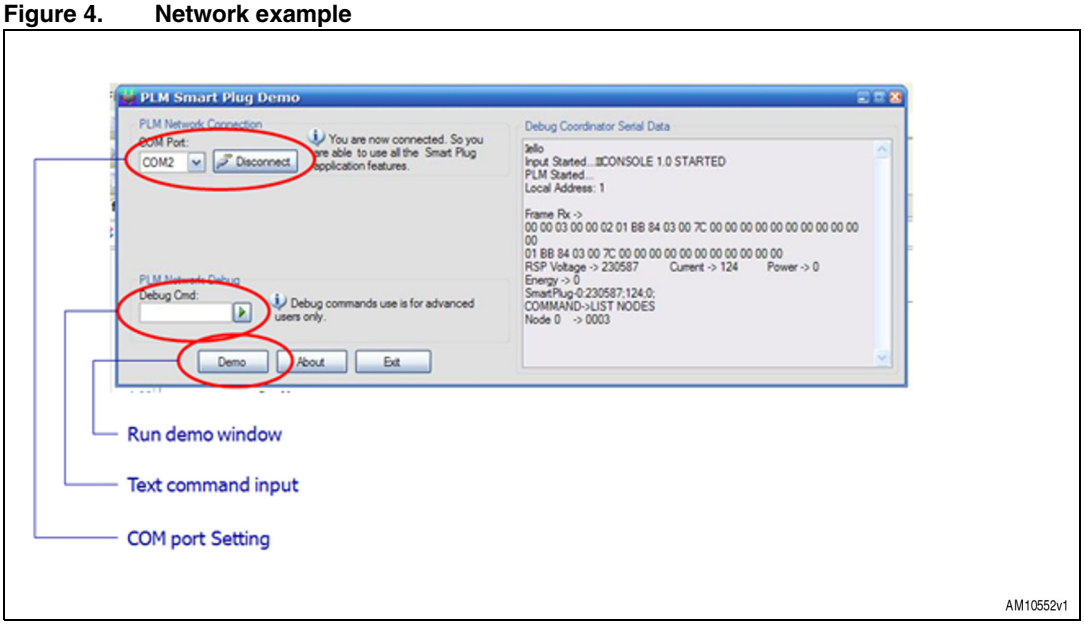
These strings can easily interpreted by a PC application for a better presentation.

Table 4. Classes variables description

Class	Description
“cons”	Information variable that stores the power consumption. It is a read-only variable.
“all”	Information variable that stores all measurements: – Voltage [mVolt] – Current [mA] – Power [mW] – Energy [Wh] It is a read-only variable.
“status”	Information variable that stores the status the output relay. It is a read/write variable.

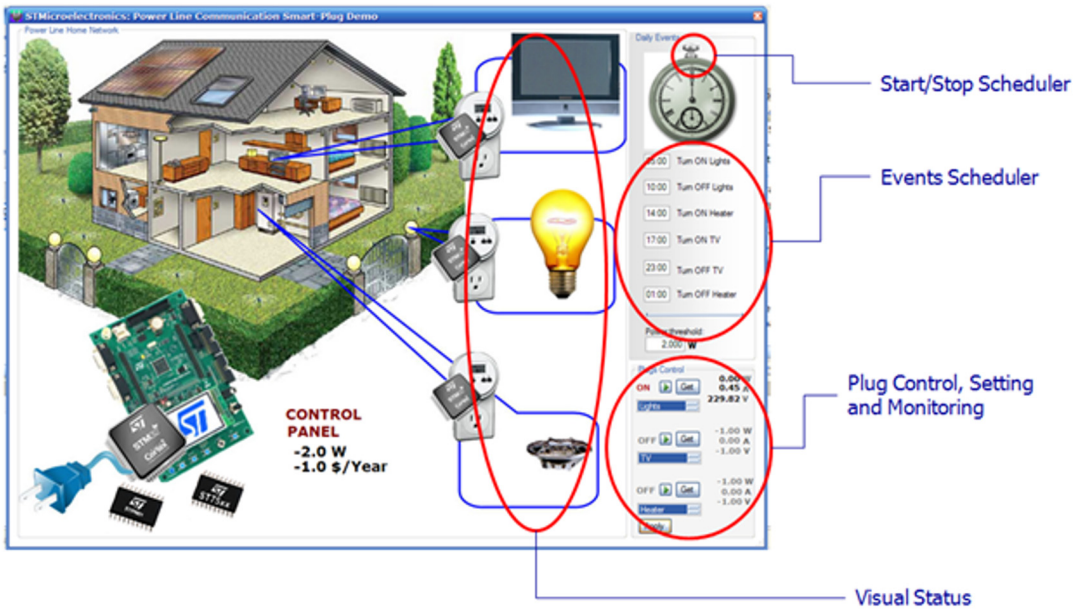
On top of the “text user interface” described above, a demo PC GUI has been developed working with only three smartplugs and one data concentrator. When the application is opened, it shows the window in *Figure 4*, which allows to open the COM port for communication with the data concentrator board and to use the text debug command and also show response messages.

Figure 4. Network example



The demo window is shown by clicking on the “Demo” button (the window, illustrated in *Figure 5*, is shown).

Figure 5. Demo PC GUI



The window allows to identify, set the label, get information from each smartplug and monitor the measurement variables. Once all labels are chosen, click the “Apply” button to assign them. The smartplug can be controlled manually by the “plug control, setting and monitoring” section or automatically by the “events scheduler” section of the window. Once the scheduler is set, click on the clock control to start/stop it. The status of the three

smartplugs is also shown visually, considering three typical loads: a television, a lamp, and a heater.

The smartplug application layer sends measurement information periodically only if the measured power consumption changes, in order to avoid unnecessary network overload, so if the user wants to get “fresh” data click on the “Get” button of the smartplug from which the user wants data.

2.4 Board and application limitations

The smartplug is for demonstration purposes only so there are some limitations:

- At startup there is a delay before the smartplugs start to send data to the concentrator
- The STPM01 calibration hasn't been done to obtain the accuracy necessary for fiscal metrology
- The relay has been tested with a maximum load equal to 1.8 kW.

3 PLM network and frames

Details regarding the network information and frames can be found in the PLM smartplug FW UM1459 user manual and in the AN3046 application note.

3.1 PLM network parameters

During startup, each node configures the ST7540 with the following parameters:

Table 5. ST7540 configuration

Configuration parameter	Parameter value
Carrier frequency	132.5 kHz
Baud rate	2400 bps
Deviation	0.5
Watchdog	Disabled
Transmission timeout	Disabled
Frequency detection time	300 msec.
Detection method	Preamble detection with conditioning
Mains interfacing mode	Synchronous
Output clock	Off
Output voltage level freeze	Disabled
Header recognition	Enabled
Frame length count	Disabled
Header length	16 bits
Extended register	Enabled
Sensitivity mode	Sensitivity high
Input filter	Enabled
Frame header	0xE389
Frame length	1
Configuration bytes values	0x1 0x89 0xE3 0xF7 0x94 0x17

4 Bill of material and schematics

Table 6. BOM

Reference	Part / value	Tolerance %	Voltage current	Watt	Technology information	Package-foot-print	Manufacturer	Manufacturer code	RS/Distrelec /other code	More info
C5,C6	22 pF	+/-10%	50 V		Ceramic capacitor X7R	SMD 0603				
C122	470 nF	+/-10%	50 V		Ceramic capacitor X7R	SMD 0805				
C7	22 pF	+/-10%	50 V		Ceramic capacitor X7R	SMD 0603				
C11,C12	33 pF	+/-10%	50 V		Ceramic capacitor X7R	SMD 0805				
C14,C27, C103C114, C115	10 nF	±10%	50 V		Ceramic capacitorX7R	SMD 0603	muRata	GRM188R71H103KA01D	RS code: 204-0779	
C15,C17, C24	10 µF	±10%	16 V		Ceramic capacitorX7R	SMD 1206	KEMET	C1206C106K4PAC7800	RS code: 648-0755	
C16,C18, C25,C109, C110,C111 ,C112,C113,C97,C98, C99,C100, C104	100 nF	±10%	50 V		Ceramic capacitorX7R	SMD 0603	muRata	GRM188R71H104KA93D	RS code: 624-2480	
C21,C33	100 pF	±5%	50 V		Ceramic capacitor COG	SMD 0603	muRata	GRM1885C1H101JA01D	RS code: 653-0327	
C22	10 µF	±10%	10 V		Ceramic capacitor X5R	SMD 0805	muRata	GRM21BR61A106KE19L	RS code: 106-846	

Table 6. BOM (continued)

Reference	Part / value	Tolerance %	Voltage current	Watt	Technology information	Package-foot-print	Manufacturer	Manufacturer code	RS/Distrelec /other code	More info
C23	68 nF	±20%	300 V		X2 capacitor	Through hole	Any		Distrelec code: 821885	
C26	6.8 nF	±5%	50 V		Ceramic capacitor COG	SMD 1206	muRata	GRM3195C1H682JA01D	RS code: 624-2597	
C30	15 pF	±5%	50 V		Ceramic capacitor COG	SMD 0402	muRata	GRM1555C1H150JZ01D	RS code: 624-2935	
C31	22 pF	±5%	50 V		Ceramic capacitor COG	SMD 0402	muRata	GRM1555C1H220JZ01D	RS code: 624-2187	
C32	270 pF	±5%	50 V		Ceramic capacitor COG	SMD 0603	KEMET	C0603C271J5GAC7867	RS code: 147-207	
C95	100 µF	+/-20%	16 V		Electrolytic capacitor	SMD	Any		RS code: 565-695	
C96	47 µF	+/-20%	25 V		Electrolytic capacitor	SMD	Any		RS code: 565-712	
C101	10 µF	10%	10 V		Tantalium capacitor	SMD	Any		RS code: 464-7619	
C123	10 nF	+/-10%	50 V		Ceramic capacitor X7R	SMD 0805				
C124	1 nF	+/-10%	50 V		Ceramic capacitor X7R	SMD 0805				
C108	1 nF	+/-10%	50 V		Ceramic capacitor X7R	SMD 0603				
C116,C117	4.7 µF	+/-20%	400 V		Electrolytic capacitor	Through hole	Any		RS code: 365-4745	
C118	470 pF	+/-10%	400 V		Ceramic capacitor X7R	SMD 1206	Any		RS code: 192-718	

Table 6. BOM (continued)

Reference	Part / value	Tolerance %	Voltage current	Watt	Technology information	Package-foot-print	Manufacturer	Manufacturer code	RS/Distrelec /other code	More info
C119	470 µF	+/-20%	16 V		Electrolytic capacitor low ESR	Through hole	Any		Distrelec code:801839	
C120	2.2 µF	+/-10%	35 V		Tantalium capacitor	SMD	Any		RS code: 699-3324	
C121	2.2 nF	+/-20%	250 V		Y2 ceramic capacitor	Through hole	Any		RS code: 216-1595	
DL1	Red				Chip LED	SMD 0805	Any		Distrelec code: 250154	
DL2	Blue				Chip LED	SMD 0805	Any		Distrelec code: 250159	
D1	Bi-color LED red/green				LED bi-red, green	SMD	Any		RS code: 419-053	
D6,D13, D17	LL4148				Switching diode_	SOD-80	Any		Distrelec code: 601496	
D8,D10	BAT54S				Small signal Schottky diodes	SOT-23	STMicroelectronics	BAT54SFILM		
D9	SM6T15CA				Transil	SMB	STMicroelectronics	SM6T15CA		
D14	MB6S-RC				Diode bridge	SOIC4	Taiwan Semiconductor		RS code: 652-7501	
D15	STPS1H100A				High voltage power Schottky rectifier	SMA	STMicroelectronics	STPS1H100A		
D16	STTH1L06A				Turbo 2 ultrafast high voltage rectifier	SMA	STMicroelectronics	STTH1L06A		

Table 6. BOM (continued)

Reference	Part / value	Tolerance %	Voltage current	Watt	Technology information	Package-foot-print	Manufacturer	Manufacturer code	RS/Distrelec /other code	More info
F1	1 A				Fuse with clip 1 A	SMD	Schurter	3404.2416.22	RS code: 703-2742	
IC3	LD1117ADT33TR				Low drop fixed and adjustable positive voltage regulators	DPAK	STMicroelectronics	LD1117ADT33TR		
JP4,JP5	Close				Do not fit	Do not fit	Do not fit	Do not fit	Do not fit	
J1	Peak meter connector				5-way single row stripline connector (male connector) 2,54 mm pitch	Vertical through hole	Any		RS code:495-8470	
J2	JTAG				2x10-way double row stripline connector (male connector) 2,54 mm pitch	Vertical through hole	Any		RS code: 1732764	
J3	USART				3-way single row stripline connector (male connector) 2,54 mm pitch	SMD	Tyco Electronics	1241150-3	RS code: 528-6237	
J4	CON3				3-way vertical closed header, 5.08 mm pitch	Through hole	PHOENIX CONTACT	SL 5.08/3/180B	RS code: 294-8443	
J6	CAL CON				2x10-way double row stripline connector (male connector) 2,54mm pitch	Vertical through hole	Any		RS code: 1732764	

Table 6. BOM (continued)

Reference	Part / value	Tolerance %	Voltage current	Watt	Technology information	Package-foot-print	Manufacturer	Manufacturer code	RS/Distrelec /other code	More info
J7	CON2				2-way vertical closed header, 5.08 mm pitch	Through hole	PHOENIX CONTACT	SL 5.08/2/180B4.5	RS code: 294-7428	
J8	RFID reader				4-way single row stripline connector (male connector) 2,54 mm pitch	SMD	Tyco Electronics	1241150-4	RS code: 528-6243	
L5	22 µH	±10%	2.1 A		SMD inductor	SMD	EPCOS	B82464A4223K	RS code: 496-0445	
L6	220 µH	±10%	240 mA		SMD inductor	SMD	EPCOS	B82462A4224K	RS code: 495-8048	
L8	470 µH	+/-5%	170 mA		Inductor	Through hole	Any		RS code: 191-0677	
L9	10 µH	+/-10%	500 mA		Inductor	Through hole	Any		RS code: 191-0481	
Q1,Q2	BC857B				PNP transistor	SOT23	Any		RS code: 445-2051	
Q5	2STR1215				Low voltage fast-switching NPN power transistor	SOT-23	STMicroelectronics	2STR1215		
R6	1.1 kΩ	+/-1%		0.1 W	Resistor	SMD 0603				
R7	47 kΩ	+/-1%		0.1 W	Resistor	SMD 0603				
R8	15 kΩ	+/-1%		0.1 W	Resistor	SMD 0603				
R9,R88, R71,R72, R73,R108, R109	4.7 kΩ	+/-1%		0.1 W	Resistor	SMD 0603				
R10	13 kΩ	+/-1%		0.1 W	Resistor	SMD 0603				

Table 6. BOM (continued)

Reference	Part / value	Tolerance %	Voltage current	Watt	Technology information	Package-foot-print	Manufacturer	Manufacturer code	RS/Distrelec /other code	More info
R12,R62, R68,R90, R93	1 kΩ	+/-1%		0.1 W	Resistor	SMD 0603				
R13	2.7 kΩ	+/-1%		0.1 W	Resistor	SMD 0603				
R14	1.8 kΩ	+/-1%		0.1 W	Resistor	SMD 0603				
R17	470 Ω	+/-1%		0.1 W	Resistor	SMD 0603				
R19,R85, R86,R87	2.4 kΩ	+/-1%		0.1 W	Resistor	SMD 0603				
R20	56 kΩ	+/-1%		0.1 W	Resistor	SMD 0603				
R21,R22, R96,R97, R101,R102	261 kΩ	+/-1%		1/8 W	Mini melf resistor	SMD 0805	Any		Digi-Key code: RT0805FRE 07261KL-ND	
R61,R106	1 kΩ	+/-5%		1/8 W	Resistor	SMD 0805				
R74,R76, R77,R78, R79	10 kΩ	+/-5%		0.1 W	Resistor	SMD 0603				
R112,R118	10 kΩ	+/-5%		1/8 W	Resistor	SMD 0805				
R69,R70	82 Ω	+/-5%		1/8 W	Resistor	SMD 0805				
R75	1 MΩ	+/-5%		0.1 W	Resistor	SMD 0603				
R89	560 Ω	+/-1%		0.1 W	Resistor	SMD 0603				
R91,R92	6.8 Ω	+/-1%		0.1 W	Resistor	SMD 0603			Farnell code: 1500646	
R94	2 MΩ	+/-1%		1/4 W	Resistor	SMD 1206				
R95	0	+/-1%		0.1 W	Resistor	SMD 0603				

Table 6. BOM (continued)

Reference	Part / value	Tolerance %	Voltage current	Watt	Technology information	Package-foot-print	Manufacturer	Manufacturer code	RS/Distrelec /other code	More info
R98,R103	475 Ω	+/-1%		1/8 W	Mini melf resistor	SMD 0805	Any		Digi-Key code: RT0805FRE 07475RL	
R99	43 kΩ	+/-1%		0.1 W	Resistor	SMD 0603				
R100	100 Ω	+/-1%		0.1 W	Resistor	SMD 0603				
R105	1 kΩ (do not fit)	+/-1%		1/4 W	Resistor	SMD 1206				
R110	22 Ω	+/-5%		1 W	Fuse resistor	Through hole	Any		RS code: 214-0920	
R111	120 kΩ	+/-5%		1/4 W	Resistor	SMD 1206				
R113	10 Ω	+/-5%		1/8 W	Resistor	SMD 0805				
R114	27 kΩ	+/-1%		1/8 W	Resistor	SMD 0805				
R115	4.7 kΩ	+/-1%		1/8 W	Resistor	SMD 0805				
R116	2.2 Ω	+/-1%		1/8 W	Resistor	SMD 0805				
R117	22 Ω	+/-1%		1/8 W	Resistor	SMD 0805				
RV1	VAR275V		275 V		SMD varistor	SMD	EPCOS	B72650M271K72	Distrelec code: 730096	
SW4	Rst				Surface mount tactile switch	SMD	C & K	Y78B22110FP	RS code 505-9186	
SW8	Calibration settings				3-way single row stripline connector (male connector) 2,54 mm pitch	SMD	Tyco Electronics	1241150-3	RS code: 528-6237	Single stripline 3 poli

Table 6. BOM (continued)

Reference	Part / value	Tolerance %	Voltage current	Watt	Technology information	Package-foot-print	Manufacturer	Manufacturer code	RS/Distrelec /other code	More info
TP8,TP9, TP10,TP11 ,TP12, TP13, TP14,TP15 ,TP16, TP17, TP18, TP19, TP20, TP21, TP22, TP23, TP25, TP26,TP27	Test point				Test point	Test point	Test point	Test point	Test point	
T1	Current transformer				Current transformer	Through hole	VAC	T60404-E 4622-X503		
T2	Custom transformer				Custom transformer	Through hole	MAGNETICA	1921.0013 rev.2		
T3	Line transformer				Line transformer	SMD	VAC	T60403-K5024-X044		
U3	ST7540				FSK power line transceiver	HTSSOP28	STMicroelectronics	ST7540TR		
U11	STM32F103CBT6				Medium-density performance line ARM-based 32-bit MCU	LQFP48	STMicroelectronics	STM32F103CBT6		
U12	STPM01				Programmable single-phase energy metering IC with tamper detection	TSSOP20	STMicroelectronics	STPM01FTR		

Table 6. BOM (continued)

Reference	Part / value	Tolerance %	Voltage current	Watt	Technology information	Package-foot-print	Manufacturer	Manufacturer code	RS/Distrelec /other code	More info
U13	ALTAIR05T-800						STMicroelectronics			
X1	16 MHz				16 MHz crystal	SMD	Any		RS code: 547-6531	
Y1	8 MHz				8 MHz crystal	SMD	ABRACON	ABM3B-8.000 MHz-B2	RS code: 703-1997	
k2	16 A 12 Vdc coil (do not fit)		12 V/ 16 A		Low profile SPDT power relay	Through hole	OMRON	G2RL-1-E 12DC	RS code: 365-0535	
C5,C6	22 pF	+/-10%	50 V		Ceramic capacitor X7R	SMD 0603				
C122	470 nF	+/-10%	50 V		Ceramic capacitor X7R	SMD 0805				
C7	22 pF	+/-10%	50 V		Ceramic capacitor X7R	SMD 0603				
C11,C12	33 pF	+/-10%	50 V		Ceramic capacitor X7R	SMD 0805				
C14,C27, C103C114, C115	10 nF	±10%	50 V		Ceramic capacitorX7R	SMD 0603	muRata	GRM188R71H103KA01D	RS code: 204-0779	
C15,C17, C24	10 uF	±10%	16 V		Ceramic capacitorX7R	SMD 1206	KEMET	C1206C106K4PAC7800	RS code: 648-0755	
C16,C18, C25,C109, C110,C111 ,C112, C113,C97, C98,C99, C100, C104	100 nF	±10%	50 V		Ceramic capacitorX7R	SMD 0603	muRata	GRM188R71H104KA93D	RS code: 624-2480	

Table 6. BOM (continued)

Reference	Part / value	Tolerance %	Voltage current	Watt	Technology information	Package-foot-print	Manufacturer	Manufacturer code	RS/Distrelec /other code	More info
C21,C33	100 pF	±5%	50 V		Ceramic capacitor COG	SMD 0603	muRata	GRM1885C1H101JA01D	RS code: 653-0327	
C22	10 µF	±10%	10 V		Ceramic capacitor X5R	SMD 0805	muRata	GRM21BR61A106KE19L	RS code: 106-846	
C23	68 nF	±20%	300 V		X2 capacitor	Through hole	Any		Distrelec code: 821885	
C26	6.8 nF	±5%	50 V		Ceramic capacitor COG	SMD 1206	muRata	GRM3195C1H682JA01D	RS code: 624-2597	
C30	15 pF	±5%	50 V		Ceramic capacitor COG	SMD 0402	muRata	GRM1555C1H150JZ01D	RS code: 624-2935	
C31	22 pF	±5%	50 V		Ceramic capacitor COG	SMD 0402	muRata	GRM1555C1H220JZ01D	RS code: 624-2187	
C32	270 pF	±5%	50 V		Ceramic capacitor COG	SMD 0603	KEMET	C0603C271J5GAC7867	RS code: 147-207	
C95	100 µF	+/-20%	16 V		Electrolytic capacitor	SMD	Any		RS code: 565-695	
J7a	CON3				2-way cable mount screw terminal, 5.08 mm	Through hole	Phoenix Contact	BL 5.08/2	RS code: 403-875	Not mounted on PCB

Figure 6. Top page

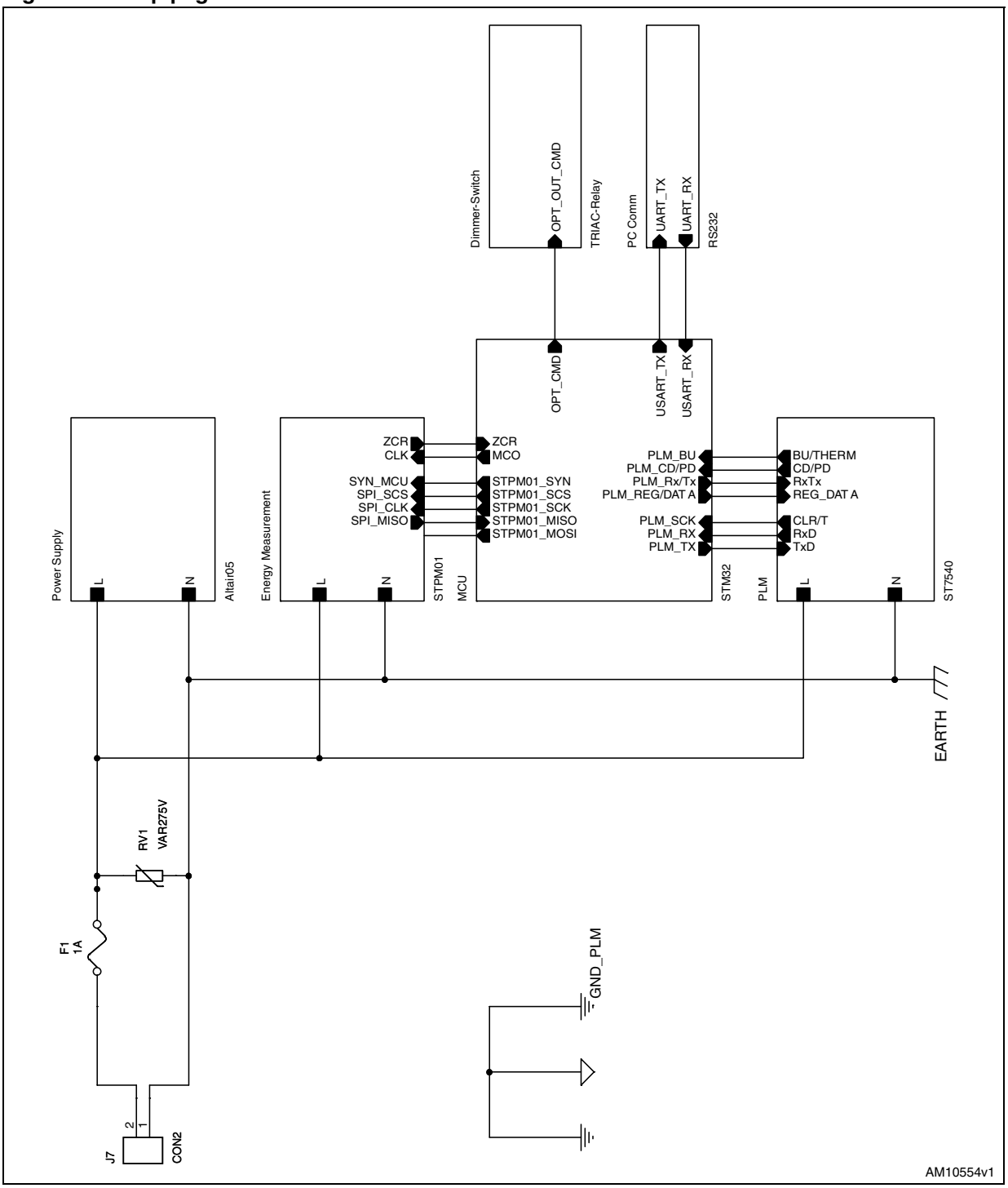


Figure 7. Power supply section

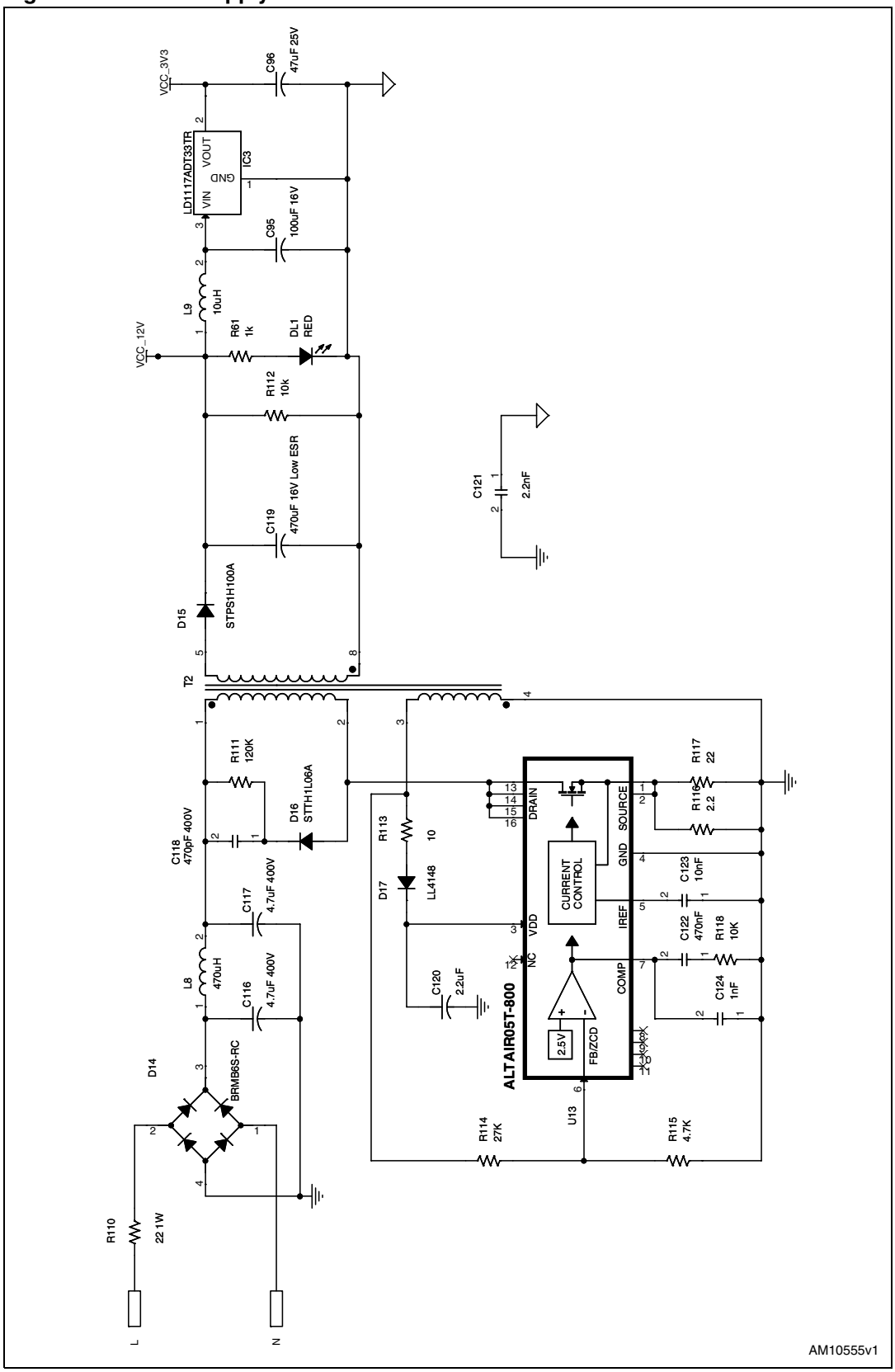


Figure 8. USART expansion connector section

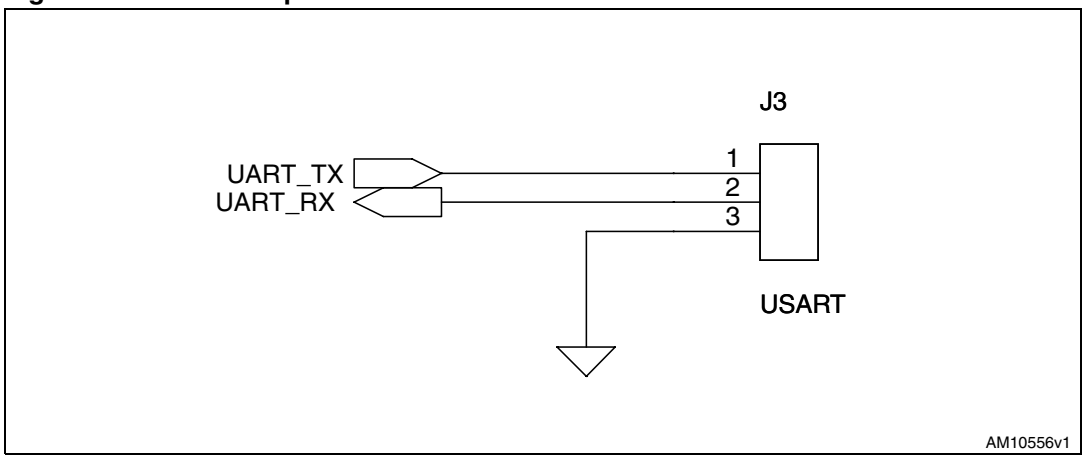


Figure 9. Power line modem section

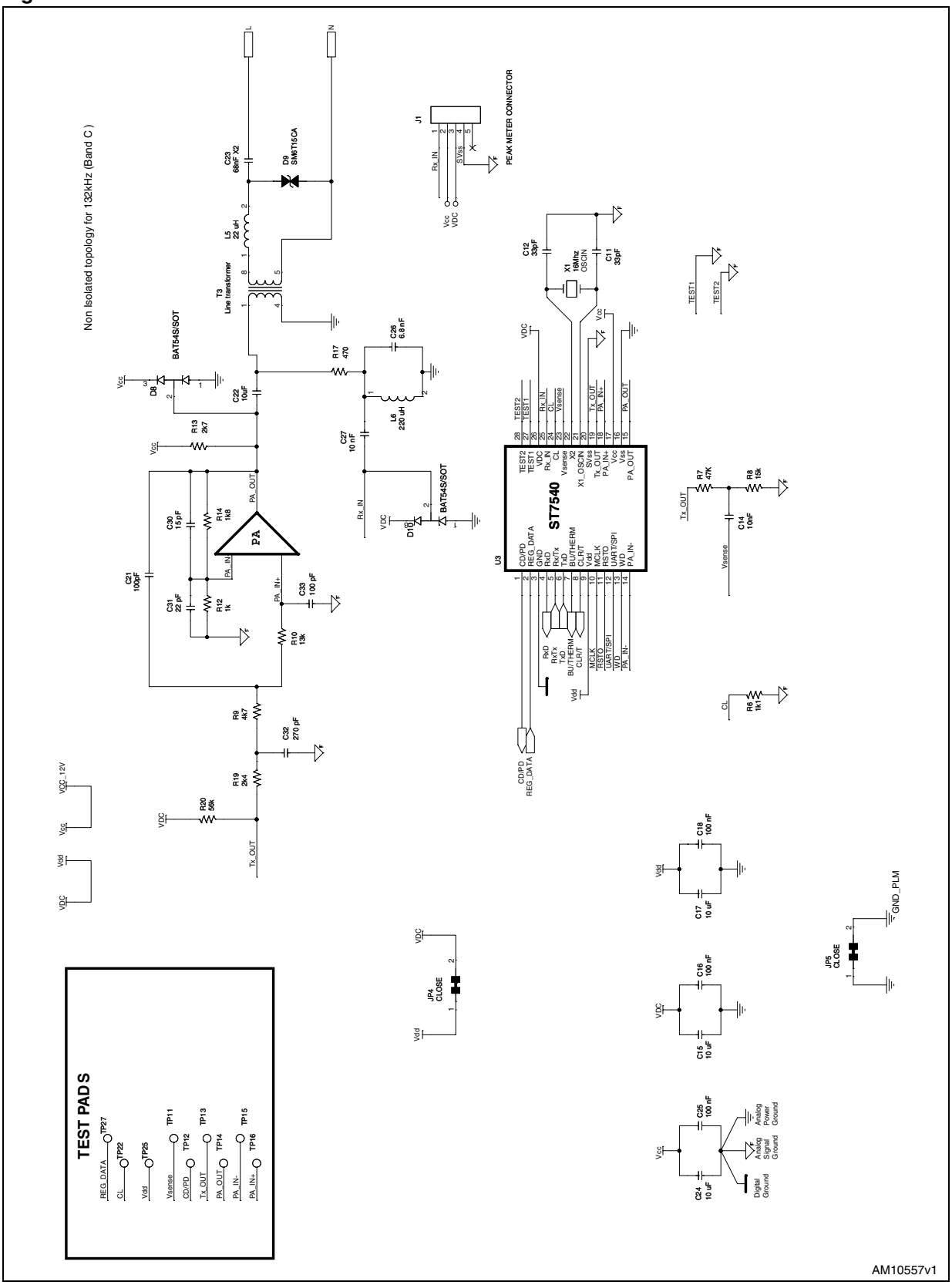


Figure 10. MCU section

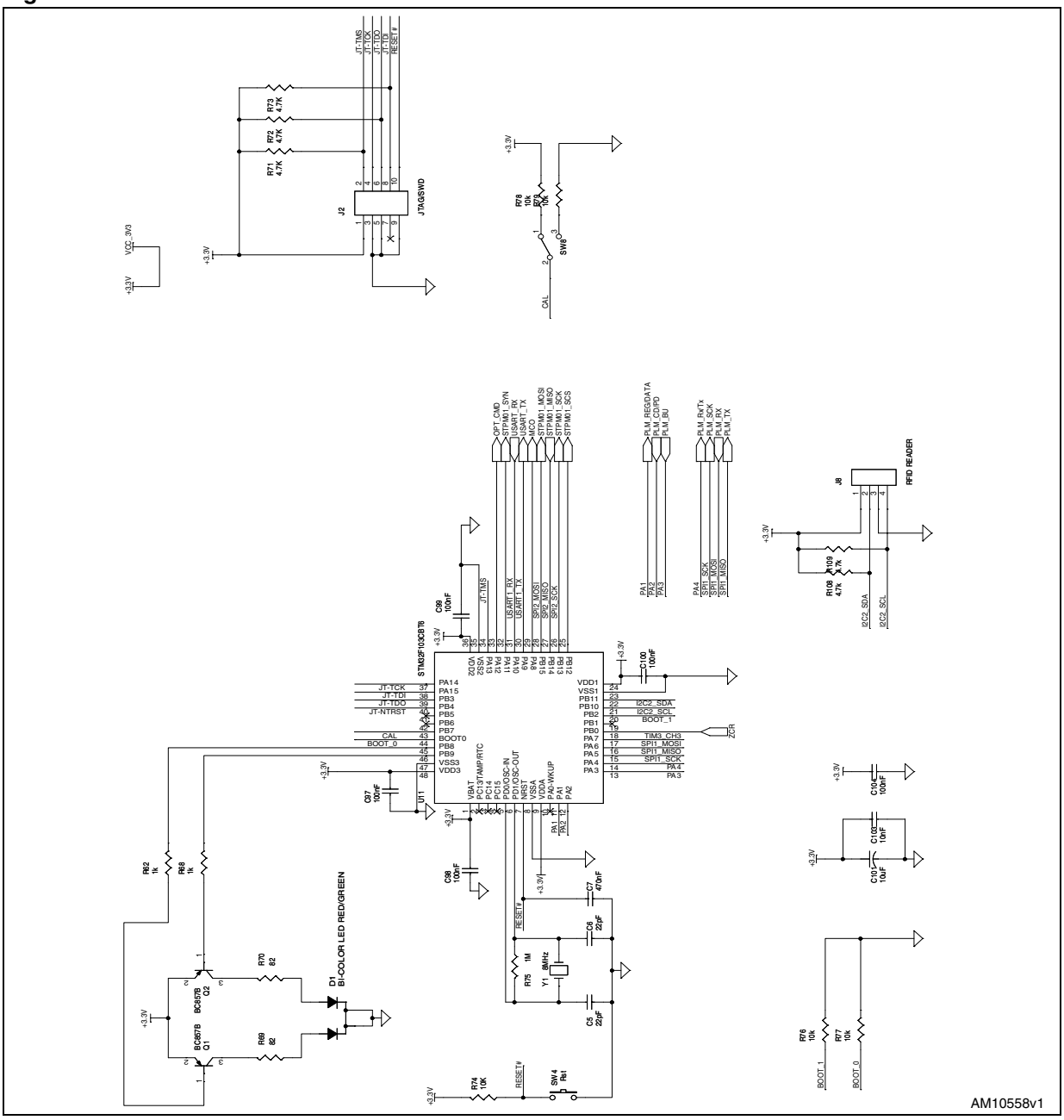


Figure 11. STPM01

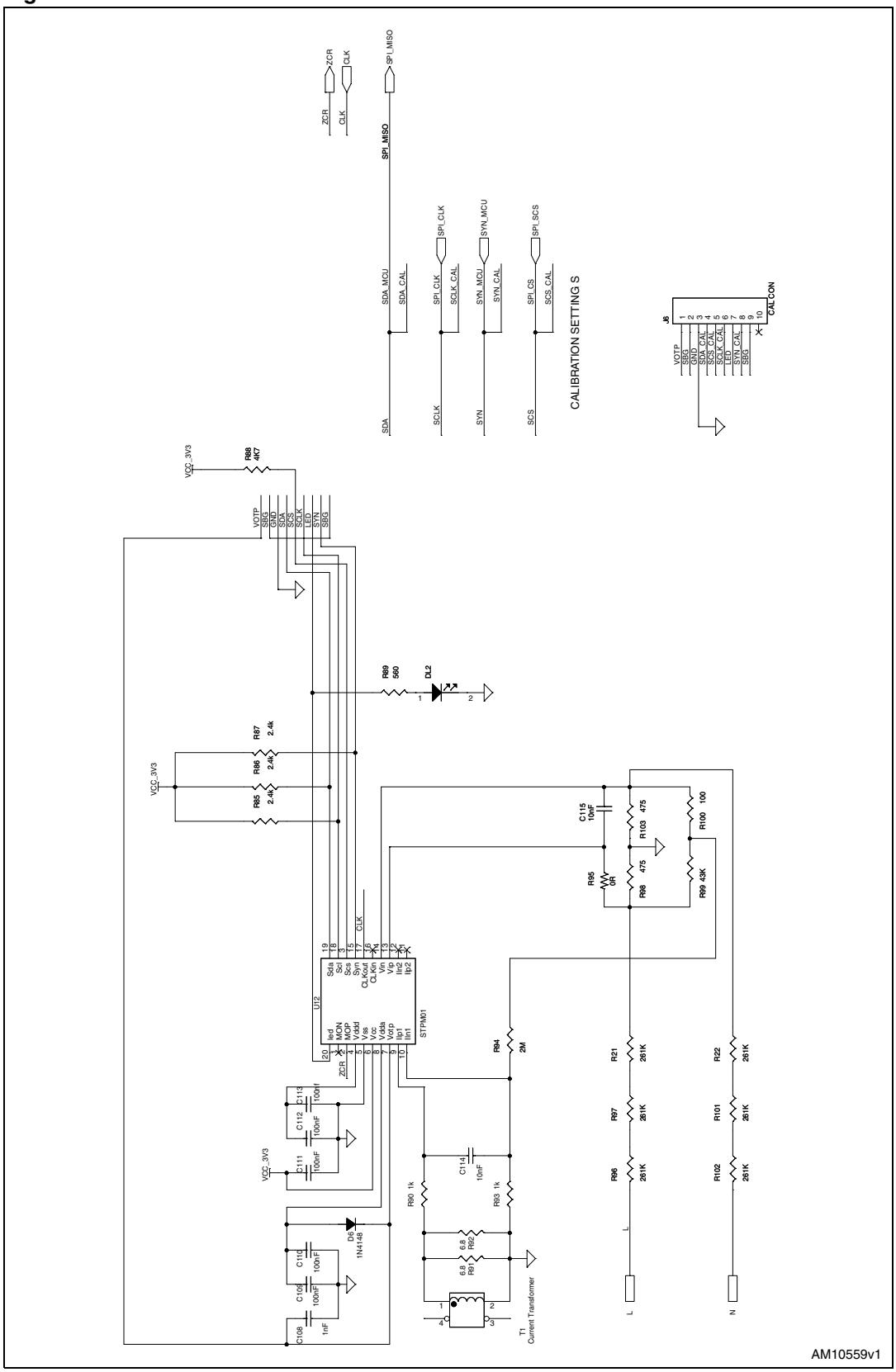
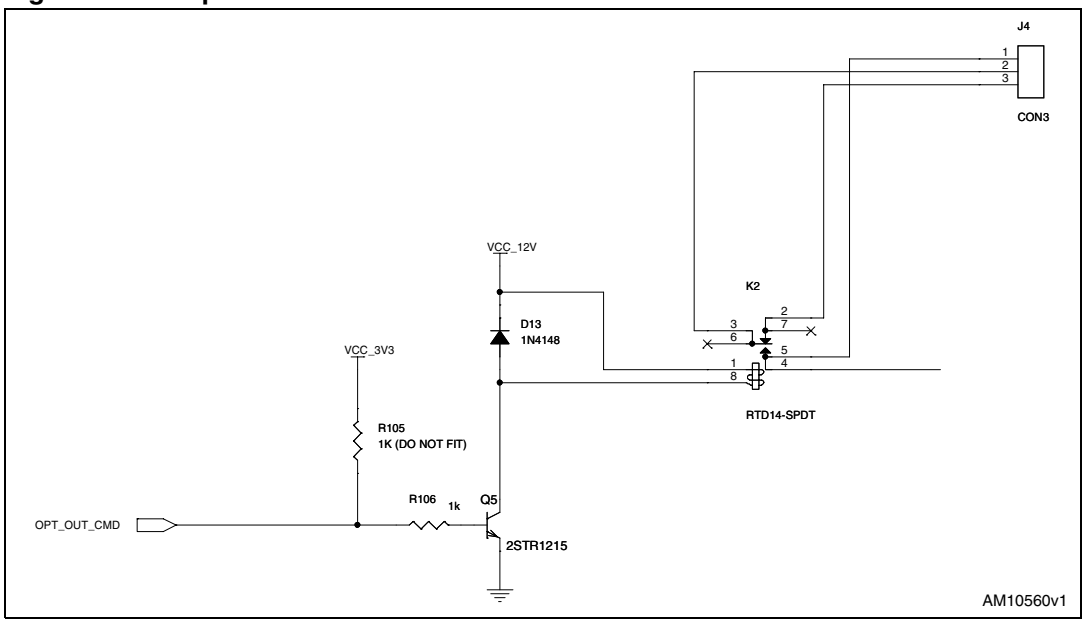


Figure 12. Output drivers



5 Revision history

Table 7. Document revision history

Date	Revision	Changes
09-Nov-2011	1	Initial release.

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